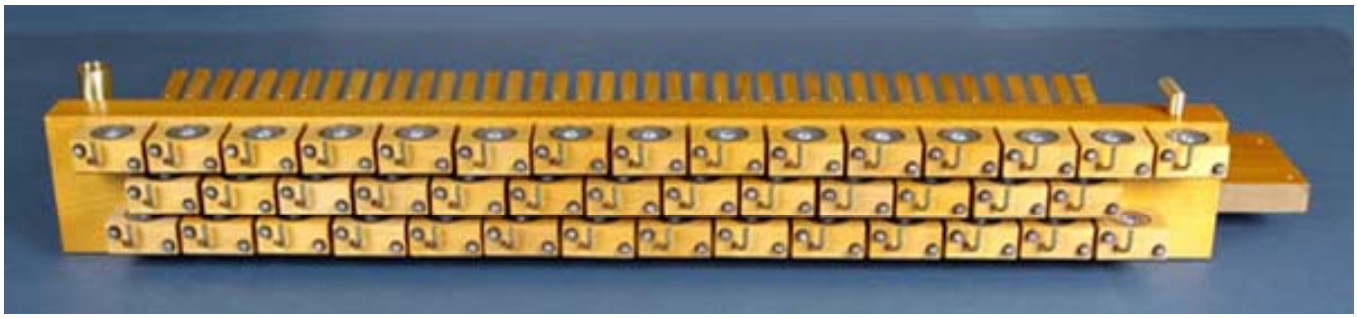
Notes on Making the Wurlitzer 105 Stack Part 1

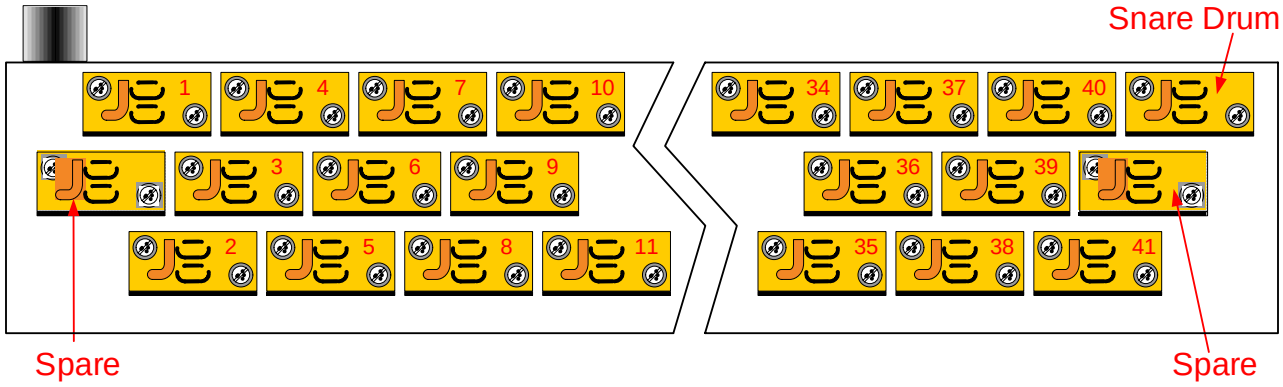


Although I wanted the 105 Stack to follow the original Wurlitzer design as much as possible, I did make a number of changes that should improve performance. First, some channels and air ways were enlarged to hopefully provide better air flow. This included making the valve input/output holes match the size of the ½"x¼" oval holes in the valves rather than simple ¼" round holes. Channels in the Channel Board and Pneumatic Board were also enlarged which required some changes in certain dimensions from the original Wurlitzer stack. In addition, the lost motion adjustment buttons, pneumatic travel limit buttons, and pneumatic guide wires found on some versions of the 105 Stack were eliminated, or rather the need for them was eliminated. The need for a pneumatic travel limit was eliminated with the design of my Wind Chest that incorporated a limit in the design of the Pallet Push Rod that has been used on a majority of original Wurlitzer Stacks. To help eliminate the need for pneumatic guide wires, the Pneumatic Fingers that push the Pallet Push Rods were given a slight bevel before gluing on the felt pads, making the fingers self-centering over the Push Rods. These changes will be discussed in more detail as they come up in the Notes.

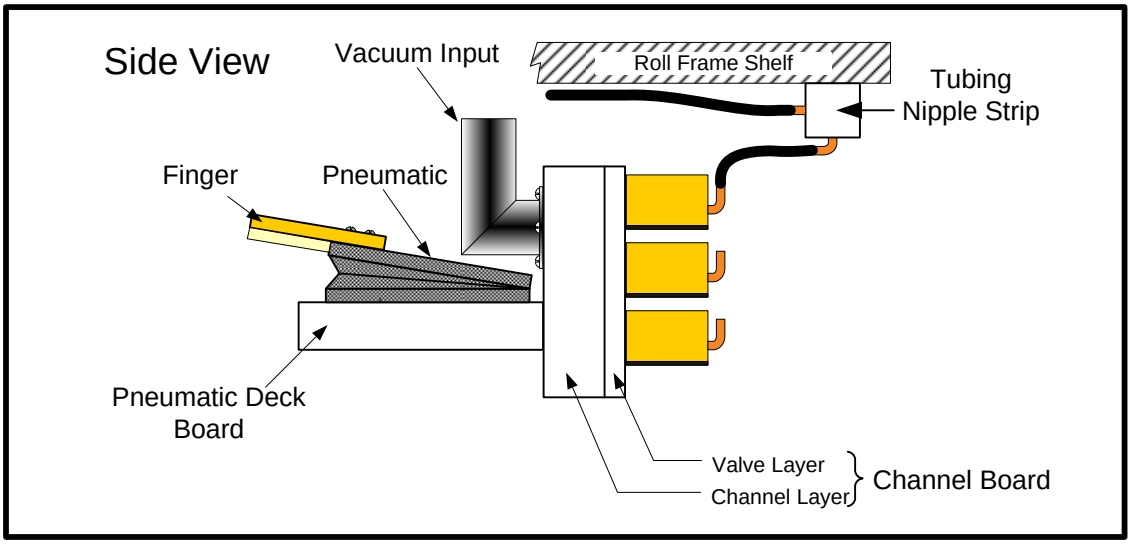
To be compatible with my Wind Chest, this version of the Stack is based on the design and templates used in making the Wind Chest. For details see the Adobe Acrobat document *105 Wind Chest Drawings* and the notes on building the 105 Wind Chest found in the Adobe Acrobat documents *Wind Chest Part 1, 2, and 3*. Templates used to construct the Stack as well as drawings documenting this version of the Stack are found in the Adobe Acrobat document *Wurlitzer 105 Stack Drawings*.

Over the years Wurlitzer had a number of versions of the original 105 Stack. Besides those variations discussed above, there were a number of options for the use of 3 stand-alone Unit Valve slots that are not dedicated to driving a pneumatic on the Stack.

If you look at Page 2 of the *Wurlitzer 105 Stack Drawings* you will see three un-numbered Unit Valves, two indicated as Spare and one assigned to the Snare Drum.



If a 105 has no stand-alone Cymbal Beater and there is a Bass Drum, the Spare valve on the left is generally assigned to the Bass Drum. If there is a Bass Drum and a stand alone Cymbal Beater, a Secondary Valve is needed to provide the necessary vacuum air flow to drive both. In such a case, the Secondary Valve is directly connected to the tracker bar and this Spare valve is not needed. Since I plan to have a stand-alone Cymbal Beater, this is the option I will use. If used, the output of a given Spare valve can be channeled to either an elbow on the top or back of the Channel Board. Sometimes the two Spare valves are used for roll frame or other control functions in which case you will see various tubing arrangements to these valves coming out the top or back of the Channel Board. The right most extra valve is generally used for the Snare Drum if one is included. This also is the option I am using for the Snare Drum.



There are two basic wood parts to the Stack: the Channel Board where the Unit Valves are mounted, and the Pneumatic Board where the individual pneumatics are glued. The Channel Board has two layers that are glued together: the Valve Layer and the Channel Layer. The drawings include information for the Tubing Nipple Strip that is used to route the tracker tubing to the individual valves.

All the wood used in the Stack is Poplar with the exception of the Valve Layer and the Tubing Nipple Strip which are Hard Maple. All the wood was first sized for exact thickness. The two boards on the right are the ¼" thick material for the Pneumatics and Pneumatic Fingers. The Channel Board layers and the Pneumatic Board were left oversized in length and width so that the outside dimensions could be cut last to clean up glue lines and/or to cut away any shellac finish spill-over on the surfaces where a gasket or sealing motor cloth needed to be glued. These operations will be expanded later in the Notes.

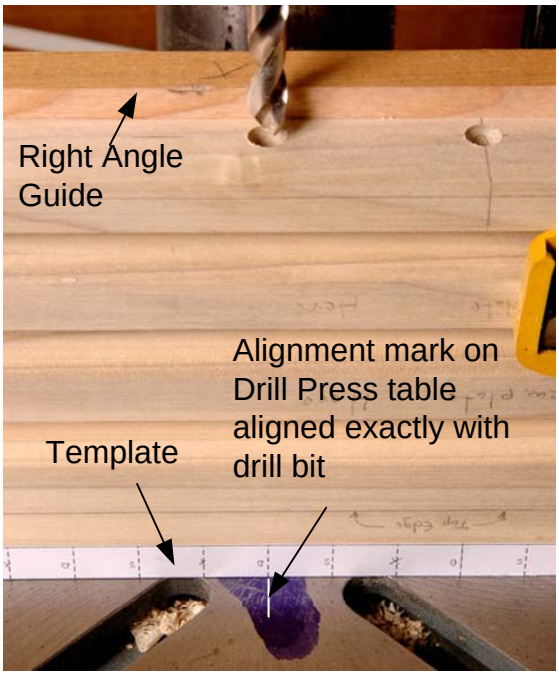
Channel Board

I used a set of paper templates to layout the Channel Board. This template set is used in a number of Stack layout operations. In this case, the long template is used across the top to give the spacing in that dimension and two of the short templates are placed at each end of the board to provide the spacing in the other dimension. A long straight edge is used to draw horizontal lines by connecting corresponding lines on the side templates and a square is used to draw spacing lines vertically using the top as a reference surface.

The vacuum input channels that run horizontally were cut with a router using a router template and a template router bit. The base outside template is a piece of ½" plywood with a rectangular hole defining the extreme outside edges of the channels. Strips of the same plywood define the boundaries of the internal edges of the channels. Both the outside template and the strips were fastened temporarily to the Channel Layer with woodturners double-sided tape for the router operation. This picture shows the trial fit of the template over the guide lines.

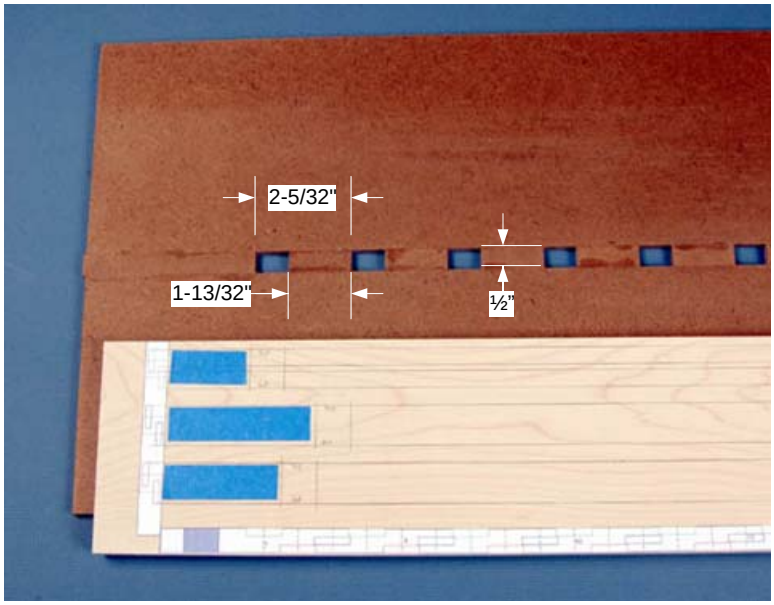
Before fastening the template with the tape, the 1" vacuum input hole was drilled completely through the board. This provided a convenient place to start the router with the bit set at a fixed ½" depth.

Here is the Channel Layer after the channels were cut and the template pieces were removed. In the next step the board was sent through the table saw to clean up the lower edge and make the two long sides parallel.

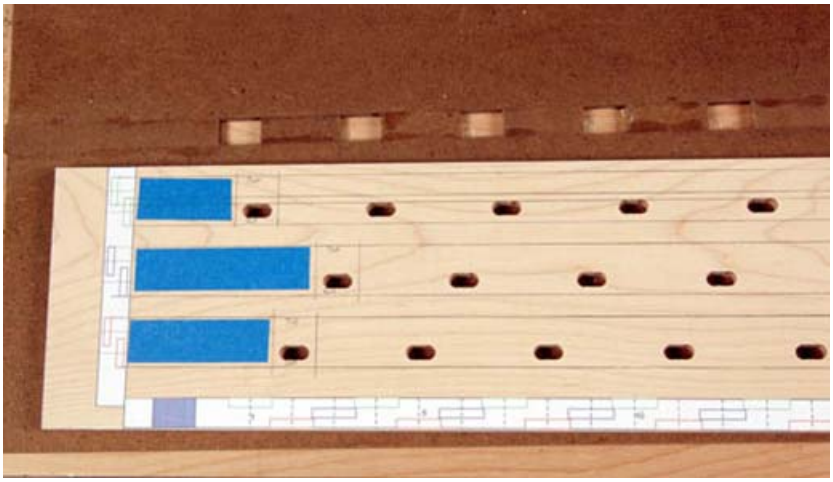


Next, both the vertical channels and the holes in the back that mate with the Pneumatic Board were drilled. To do this, two paper spacing templates were used, one fastened to the bottom and one to the back of the Layer and aligned with the first. In all cases the paper templates are fastened by spraying the back (only) of the template with spray adhesive. This allows the template to be pealed off without leaving any residue when it is removed. In each case, the quill stop on the drill press was used to set the depth of each cut. The vertical channels are normally 5/16" in the original Wurlitzer Stack. One modification made was to increase these channels to 3/8". This required a slight increase in the thickness of the Channel Layer board.

To cut the oval holes for the valve openings in the Valve Layer board, I used a hardboard router template that had 15 holes with a hole spacing of 2-5/32". The template was used in 6 different vertical positions to make the 6 lines of holes. The template was ¼" thick. The way I make all of my templates is to edge glue pieces that define the size of the holes I need. In this case I used a ¼" solid carbide "up cutting" spiral router bit with a ½" guide bushing mounted on the router. For the ¼"x½" holes needed, each opening in the template is ½"x¾".



To make the router template, I cut two pieces of hardboard about 6"x48" and cut 14 pieces ½" wide by 2-5/32" minus ¾" or 1-13/32" long and two longer ½" wide pieces for the ends. Again I used the paper spacing template to set the spacing as I glued each spacer piece to one of the larger boards by aligning the right edge of each spacer exactly on a template index mark. I then edge glued the other large board to the assembly. Masking tape stretched across the glue joint makes a surprisingly good temporary clamp for gluing here.



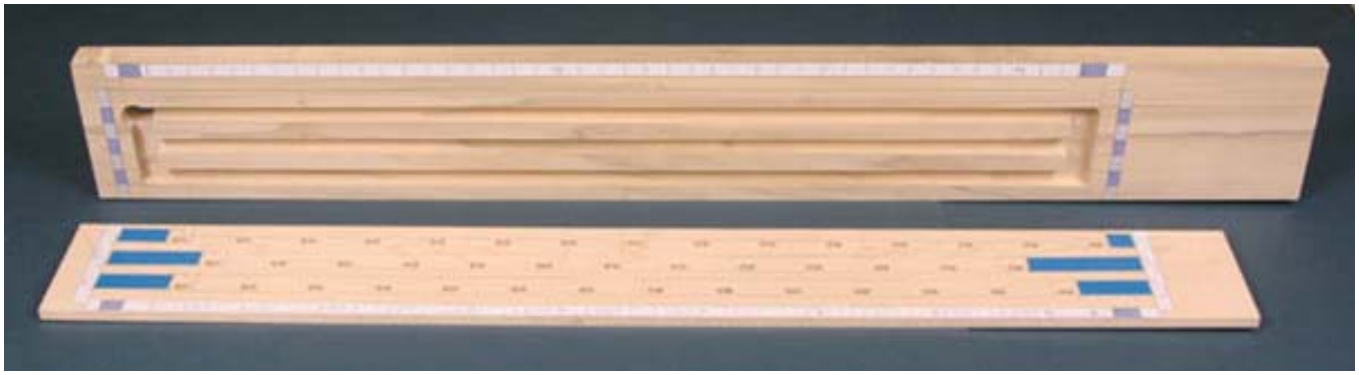
I used the router template to make the lower (input) holes for each valve row in the Valve Layer before gluing it to the Channel Layer. I put blue tape over areas where I wanted to make sure no holes were made as (what I hoped would be) an obvious indication if I misaligned the template or was about to make a hole in the wrong place.

Since the rows of valves each have a different number of hole sets (13, 14, and 15 holes), I wanted to make sure I didn't get carried away with the router since the template has 15 holes. I cut the lower holes in each row of the Valve Layer before glue-up to keep from filling the horizontal channels with a lot of shavings that I thought might be hard to get out. And I wanted to wait to make the upper (output) holes until after glue-up in order to make those holes in a single operation.

I have to thank Dana Johnson for the recommendation to use the larger oval valve channel holes over the normal ¼" holes on the original and for increasing various other channel sizes. Dana reminded me that the original use of the ¼" holes was probably one of those "good enough" type decisions that saved labor and money and probably didn't contribute to better performance. Dana's years of experience in rebuilding Wurlitzer band organs weighed in heavily here in his views.

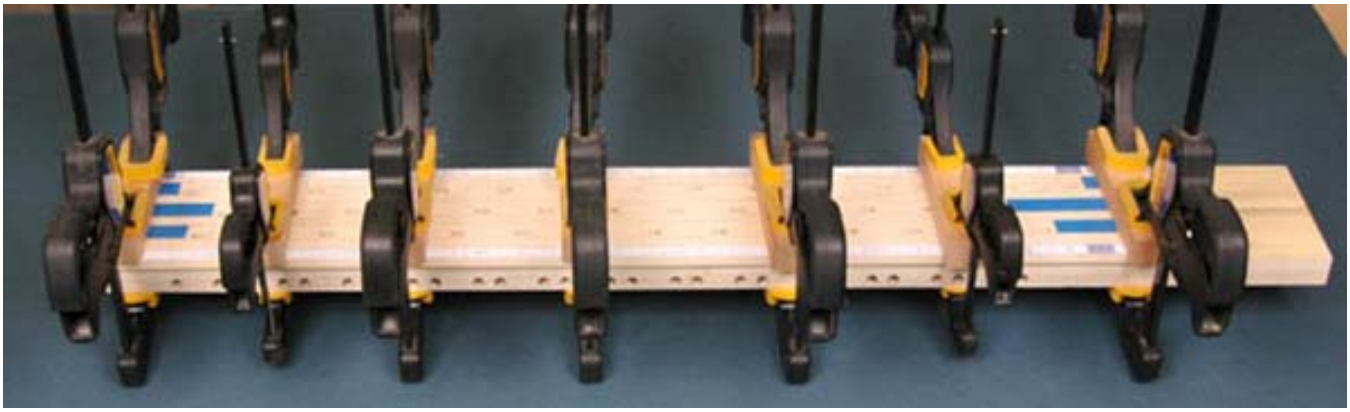
The templates for the Valve Layer layout are different from the Channel Layer templates in that the Valve Layer templates are color coded for each horizontal row and are actually little boxes that define the boundaries of the template holes, rather than the actual routed holes. This allows the router template to be aligned exactly with these lines. Actually, it is only necessary to draw boxes at each end of a row of holes on the Channel Layer board to properly align the router template to cut that row.

I find that the way to get absolutely clean and perfectly oval holes is to plunge the router at each end of the desired hole before sliding the plunged router from one side to the other to clean up the middle. If you plunge at one side and then push the plunged router to the other side, there are such great side forces from the side grabbing action of the bit, that it can pull the router to the side and affect the quality of the hole. Don't forget to set the plunge depth adjustment for the proper depth!

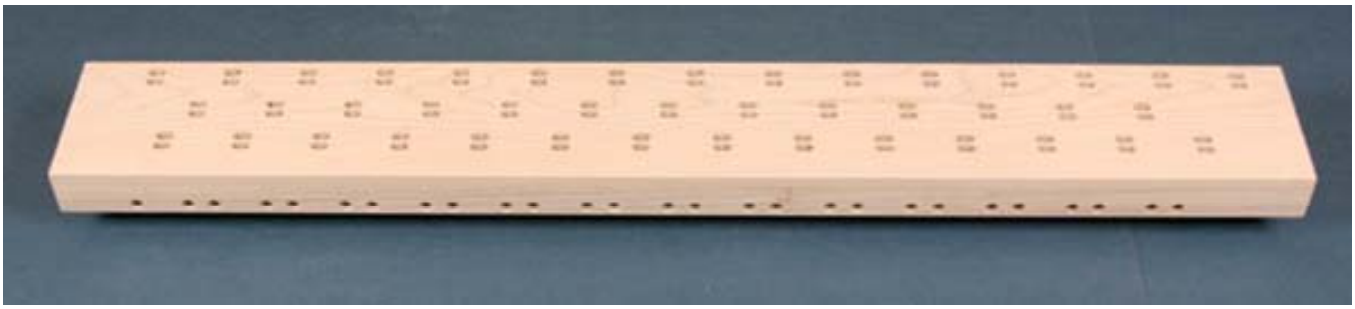


Here are the two layers of the Channel Board in preparation for glue-up.

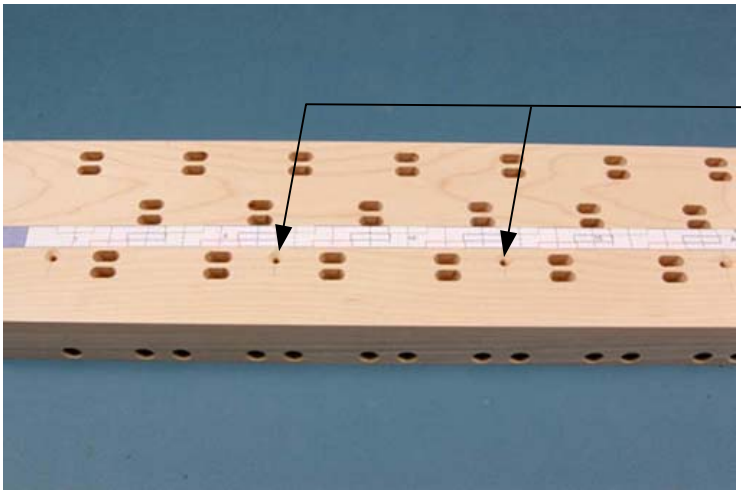
Before the paper templates are removed from the Channel Layer, make sure you have alignment lines drawn to aid in alignment of the two pieces for gluing. I used the top edge of the Channel Layer as the reference so that this surface was against the table saw for the first cut when the glue-up was cut to size. I kept the height dimension ¼" longer than the final size with the extra to be cut off the lower edge to trim away any shellac after sealing the vertical channels.



I used plenty of clamps to glue the layers together.

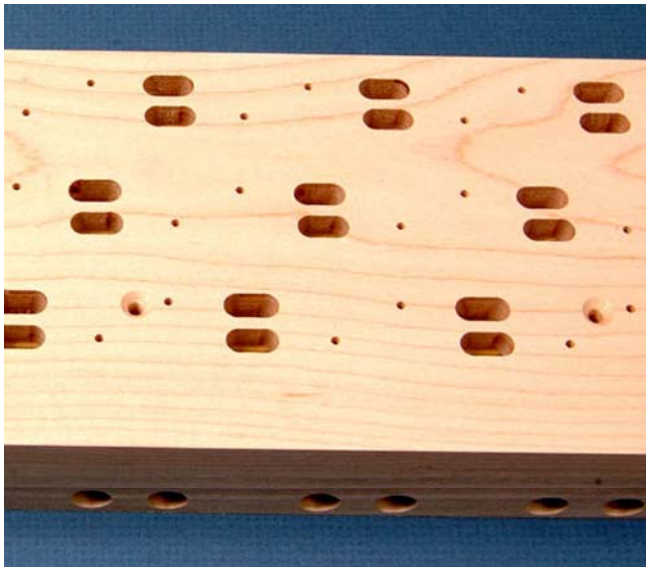


After glue-up, the upper sets of oval holes were cut. Again, don't forget to set the plunge depth on the router! The Channel Board was then trimmed to size still leaving ¼" along the bottom edge to be trimmed off later.

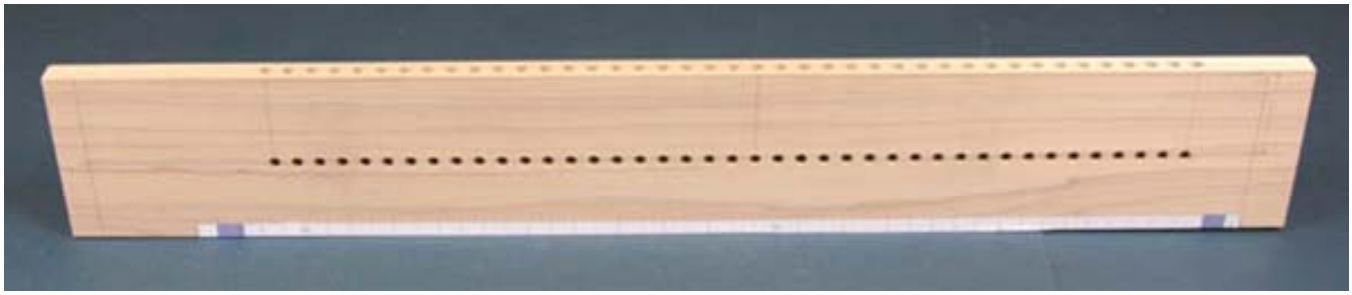


Unfortunately, I did not drill the assembly holes before I removed the template and had to tack glue another one down for this operation. The location of these holes is provided on Valve Layer paper template.

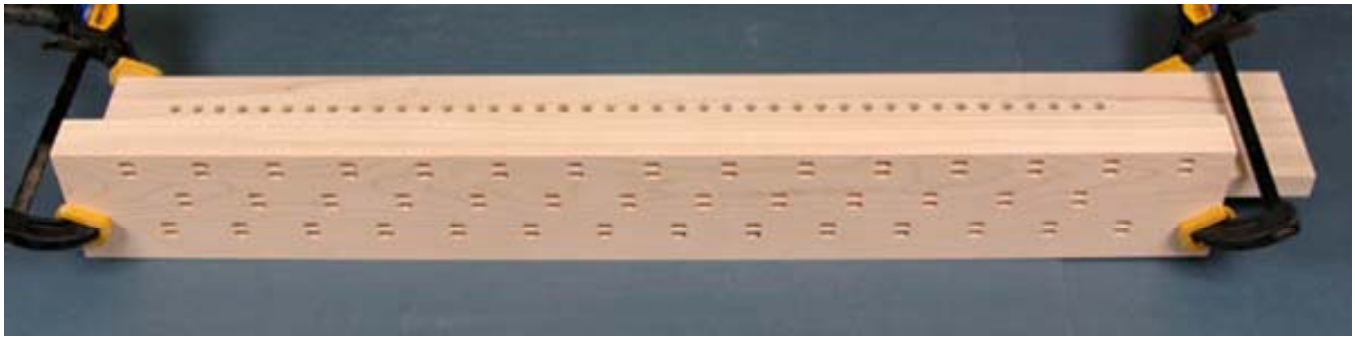
Next, the holes were pre-drilled for mounting the Unit valves. After exactly locating the left hand screw of the #1 Unit Valve, horizontal and vertical paper templates were aligned to this location and used to locate the left hand screw location for each valve. These holes were predrilled with a #45 drill. To very accurately locate the second hole for each valve I used one of the valves as a marking guide. The valve was positioned using the previously predrilled hole and held square with the side. A transfer punch was used to locate the second hole for pre-drilling.



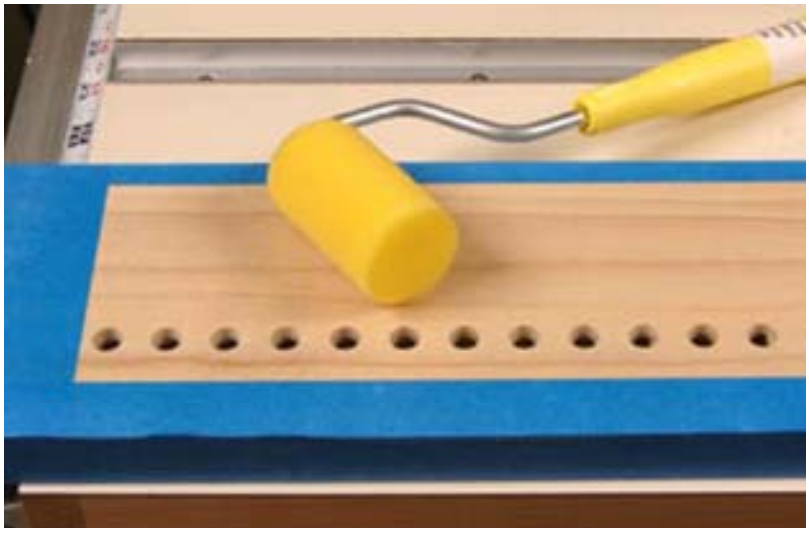
Pneumatic Board



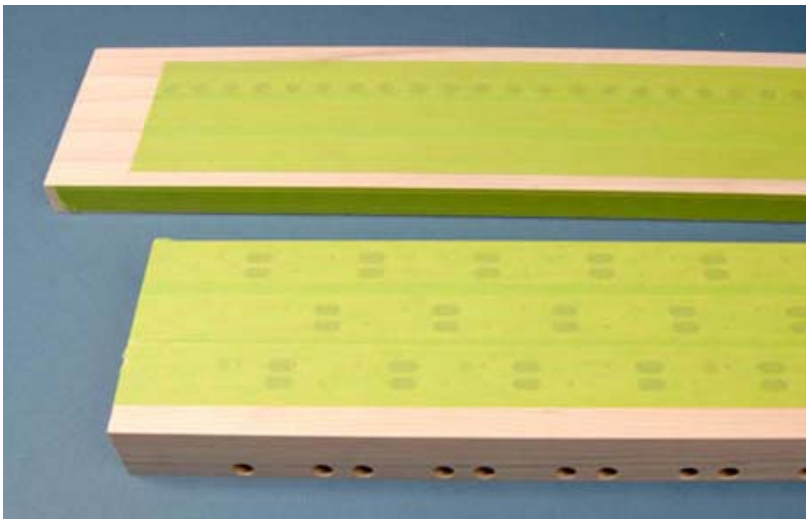
The channels in the Pneumatic Board were drilled using the same paper template and drilling process as the Channel Layer. Again, the board was cut to size with ¼" left on the side with the holes (on top in this picture) so that any shellac in the sealing operation could be cut away to allow tack gluing of the leather seal at this end. I use fish glue to do this. Some use shellac in which case the piece can be cut to final dimensions.



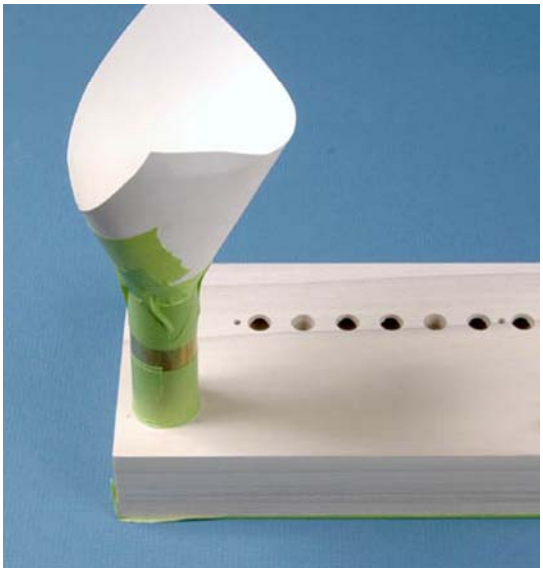
To check everything out, a trial fit of the Pneumatic and Channel Boards was made. To locate the holes for the screws that fasten the two Boards together for pre-drilling, I put a short piece of 3/8" dowel in the two end holes that connect vacuum to each pneumatic as a way to get absolute alignment between boards. While clamped in this position, I used a long transfer punch to locate and center punch a mark for pre-drilling the Pneumatic Board with a #45 drill. Pre-drilling these holes is particularly critical. Invariably this is where a split occurs causing leaks between channels. For this reason it is also important not to over tighten the screws when fastening the two Boards together.



Before sealing the channels with shellac, I coated the area on the Pneumatic board where the pneumatics would be glued with hide glue sizing. This is a thinned down hide glue that was rolled on and allowed to soak in and dry. This does two things. First, it keeps shellac from sticking to the surface which would prevent the pneumatics from bonding to that surface, and second, it improves hot hide glue bond.

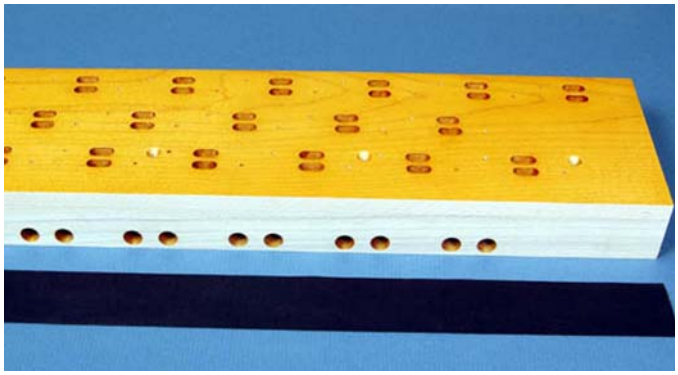


Shellac was used to both seal the internal channels and as the exterior finish. For exterior finishing the Pneumatic board was masked with tape over the sized area and the end channels. To seal the internal channels of the Channel Board, valve holes were covered with tape so that the horizontal channels could be filled with shellac to seal them and the excess drained away.



Shellac was poured into the horizontal channels through the 1" vacuum inlet hole. With a plug in this hole, the shellac was “slushed” around until all the internal surfaces were thoroughly covered. After the excess shellac was drained, all tape was removed and the piece was allowed to dry overnight. With oversized pipe cleaners as a tool, the round channels in the Pneumatic and Channel Boards were sealed with shellac.

Next, the exterior surfaces of the Stack were sprayed with shellac ready for gluing the pneumatics and final assembly.



After the finish dried, the Channel and Pneumatic boards were cut to final size providing a clean surface to glue the sealing motor cloth (as show above on the Channel Board), and tack glue the leather seal on the pneumatic board.

The Notes will continue in Part 2 with information on making the pneumatics, final construction details, and testing.